

WHAT IS CLAIMED IS:

1        A computer system coupled with a pipelined network comprising:  
2              a plurality of initiator nodes coupled to send packets, into the network;  
3              a plurality of target nodes coupled to receive packets sent into the network;  
4              and  
5              a plurality of pipeline stages for transmitting data across the network, each  
6              pipeline stage consuming a predetermined time period, thereby  
7              providing for a predetermined time period for transmission for each  
8              packet successfully sent between one of the initiator nodes and one of  
9              the target nodes.

1        2.        The computer system as recited in claim 1 wherein the pipelined  
2        network is synchronous in that boundaries of all the pipeline stages are aligned.

1        3.        The computer system as recited in claim 1, wherein the pipeline stages  
2        include an arbitration stage, a transfer stage, an acknowledge stage, the stages being in  
3        a fixed time relation to each other.

1        4.        The computer system as recited in claim 3, the pipeline stages having  
2        equal length.

1        5.        The computer system as recited in claim 3 further comprising a check  
2        stage in which an initiator node checks if transmission of a sent packet was  
3        successful.

1        6.        The computer system as recited in claim 3 further comprising  
2        arbitration logic coupled to the initiator nodes, the pipelined network, and the target  
3        nodes, the initiator nodes supplying requests to the arbitration logic for transmission  
4        of respective packets to respective target nodes during respective arbitration stages,  
5        the arbitration logic responsive to the initiator node requests to schedule packet  
6        transmission across the network.

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1        7. The computer system as recited in claim 6 wherein for a particular  
2 transfer, the arbitration logic is coupled to receive an indication from a particular  
3 target node for the particular transfer as to whether the particular transfer can be  
4 supported in the particular target node.

1        8. The computer system as recited in claim 3 wherein during the transfer  
2 stage the packet supplied by the initiator traverses the network.

1        9. The computer system as recited in claim 3 wherein during the  
2 acknowledge stage, an acknowledge packet is returned by the target node to the  
3 initiator node.

1        10. The computer system as recited in claim 9 wherein the acknowledge  
2 packet is checked by the initiator during the check stage.

1        11. The computer system as recited in claim 10 wherein the check stage is  
2 fixed in time in relation to the arbitration stage, thereby allowing the initiator node to  
3 check for successful completion of sending the packet a fixed time after the  
4 arbitration stage.

1        12. The computer system as recited in claim 3 wherein the transfer stage  
2 includes multiple pipeline stages to transmit the transfer packet across the network.

1        13. The computer system as recited in claim 3 wherein the acknowledge  
2 stage includes multiple stages to transmit the acknowledge packet across the network.

1        14. The computer system as recited in claim 3 wherein the number of  
2 bytes transferred per request during the transfer stage is fixed.

1        15. The computer system as recited in claim 3 wherein outstanding  
2 transactions across the pipelined network are delivered in order.

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1        16. The computer system as recited in claim 1 further comprising a switch  
2 coupling the nodes on the pipelined network.

1        17. The computer system as recited in claim 16 wherein the pipelined  
2 network comprises a plurality of cascaded switches.

1        18. A method for transmitting information across a pipelined computer  
2 network, comprising:  
3              transmitting the information from an initiator node to a target node using a  
4              plurality of pipeline stages in the computer network, each pipeline  
5              stage having a fixed forwarding delay; and  
6              overlapping an operation in one pipeline stage with another operation in  
7              another pipeline stage.

1        19. The method as recited in claim 18 further comprising:  
2              requesting a path through the network from the initiator node to the target  
3              node during an arbitration stage from arbitration logic;  
4              sending at least one data packet containing the information from the initiator  
5              node to the target node during one or more transfer stages; and  
6              sending an acknowledge packet containing status of receipt of the data packet  
7              from the target to the initiator during one or more acknowledge  
8              pipeline stages.

1        20. The method as recited in claim 19 further comprising during the  
2 arbitration stage:  
3              the arbitration logic communicating with the target node to determine if the  
4              target node can accept a packet from the initiator node; and  
5              wherein during the arbitration stage, the arbitration logic provides a grant  
6              indication to the initiator node to indicate that the initiator node can  
7              transmit the packet during a subsequent transfer stage.

1        21. The method as recited in claim 19 wherein at least one of the  
2 arbitration stage, the transfer stage and the acknowledge stage are overlapped.

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22. The method as recited in claim 19 wherein the pipelined network  
2 includes a first switching circuit coupling the initiator node and the target node, the  
3 first switching circuit carrying information transmitted during the transfer stage.

1       23. The method as recited in claim 22 wherein the pipelined network  
2 includes a second switching circuit coupling the initiator node and the target node, the  
3 second switching circuit being independent of the first switching circuit and wherein  
4 information for at least a portion of pipeline operations are carried over the second  
5 switching circuit simultaneously with operations for the transfer stage carried over the  
6 first switching circuit.

1       24. The method as recited in claim 23 wherein information for the  
2 arbitration and acknowledge stages are carried over the second switching circuit  
3 during arbitration and acknowledge pipeline stages, respectively.

1       25. The method as recited in claim 19 further comprising generating a  
2 schedule for traversing the pipeline stages of the network in the arbiter, the schedule  
3 determining for each slot on the pipeline, each slot being a length of a pipeline stage,  
4 which input port is connected to which output port.

1       26. A method as recited in claim 19 wherein each initiator node of a  
2 plurality of initiator nodes provides a request vector indicating one or more desired  
3 target nodes, to the arbitration logic, the request vectors for at least some of the  
4 initiator nodes including multiple target nodes and wherein the arbitration logic  
5 schedules a future pipeline slot to avoid conflicts, the arbitration logic globally  
6 scheduling use of the network.

1       27. The method as recited in claim 19 further comprising the initiator node  
2 checking the acknowledge packet a fixed number of pipeline stages after sending the  
3 transfer packet, to determine whether transmission of the information was successful.

1       28. The method as recited in claim 18 further comprising:

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scheduling usage of the network using an arbiter in response to requests from initiator nodes to allocate each stage of the pipeline so as to avoid conflicts for network resources.

1 29. The method as recited in claim 28 wherein the scheduling includes  
2 accounting for prescheduled requests, the prescheduled requests requesting periodic  
3 slots on the network.

1 30. The method as recited in claim 18 further comprising sending all  
2 information across the network in order.

1 31. A networked computer system comprising:  
2 a plurality of processing nodes, each processing node including at least one  
3 processor; and  
4 a synchronous pipelined switched network coupling the plurality of processing  
5 nodes, the pipelined network having a plurality of pipeline stages, the  
6 pipeline including at least an arbitration stage to obtain a path through  
7 the pipelined switched network, a transfer stage transferring data over  
8 the path and an acknowledge stage, each stage being of equal length.

1 32. The networked computer system as recited in claim 31 wherein the  
2 pipelined switched network comprises a first switching circuit coupling the plurality  
3 of processing nodes, the first switching circuit carrying information transmitted  
4 during the transfer stage.

1 33. The networked computer system as recited in claim 32 wherein the  
2 pipelined switched network comprises a second switching circuit coupling the  
3 processing nodes, the second switching circuit being independent of the first  
4 switching circuit and wherein at least a portion of pipeline operations are carried over  
5 the second switching circuit simultaneous with operations for the transfer stage  
6 carried over the first switching circuit.

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1           34. The networked computer system as recited in claim 31 wherein at least  
2       one of arbitration and acknowledge information for respective arbitration and  
3       acknowledge stages are transmitted over the second switching circuit.

1           35. The networked computer system as recited in claim 31 wherein the  
2       networked computer system further includes at least one storage node coupled to the  
3       plurality of processing nodes through the synchronous pipelined switched network.

1           36. The networked computer system as recited in claim 31 wherein the  
2       networked computer system further includes at least an input/output node coupled to  
3       the plurality of processing nodes through the synchronous pipelined switched  
4       network.